Pilot study evaluating the monitoring of canine diabetes mellitus in primary care practice

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ABSTRACT

Objectives This study aimed to describe how canine diabetes mellitus (CDM) is monitored in primary care practice (PCP) and to report outcomes.

Design Retrospective case review.

Setting PCP.

Participants 40 dogs of 22 different pedigrees and five crossbreeds. Median age at diagnosis was nine years and six months (eight years six months to 10 years five months). Dogs were diagnosed with CDM between January 1, 2008 and December 30, 2012 and remained with the practice to the study end or until death.

Primary and secondary outcome measures Stability achievement and death or euthanasia. Consultations for each dog were identified and recorded through records collected from the PCP (January 1, 2008 to December 30, 2012).

Results A median of three consultations per dog occurred in the first month, subsequently falling to a median of one consultation every 19 days thereafter. After the first month postdiagnosis, weight and single blood glucose concentrations were most frequently recorded at 66.8 and 42 per cent of consultations respectively and a blood glucose curve was performed infrequently (17.4 per cent). Serum biochemistry was measured at 8 per cent of consultations and urine culture at only 0.8 per cent. Median survival time (MST) for all dogs was eight months (2–21 months). Eighteen dogs stabilised within three months of diagnosis and their MST was 20.5 months, (10.25–25.75 months), significantly longer than the 22 dogs not achieving stability within three months (MST 2.5 months, 0–5.5 months) ($P<0.001$). Those dogs not surviving beyond the first month had significantly fewer consultations than those still alive ($P<0.005$).

Conclusions This pilot study indicates dogs with CDM managed solely in PCP experience limited monitoring tests and have lower MST than reported in the literature. Recruitment of a larger cohort of CDM cases from a larger number of PCP will help determine whether these results accurately represent this demographic and verify if infrequent testing is associated with a poor outcome. Importantly, prospective evaluation of decision-making around monitoring CDM in PCP is required, to help determine the effectiveness and feasibility of more frequent monitoring strategies, such as those recommended by the American Animal Hospital Association, particularly to influence MST.

INTRODUCTION

Canine diabetes mellitus (CDM) is a common endocrine disorder (prevalence of 0.3 per cent) and in most dogs is insulin dependent.[1–3] CDM therapy aims to alleviate clinical signs and improve quality of life, avoiding acute complications, such as diabetic ketoacidosis and iatrogenic hypoglycaemia and limiting chronic complications such as infections and cataracts.[4–6] Assessment of treatment efficacy is important, particularly assessing glycaemic control; good control implies effective treatment. A clinician's choice of tests to monitor glycaemic control is often based on their perceived strengths and weaknesses, as well as individual experience.[7–9] The American Animal Hospital Association (AAHA) have produced guidelines for managing CDM,[10] which recommend consultations every 7–10 days after diagnosis with a blood glucose curve (BGC) until clinical signs are controlled. The guidelines then advise quarterly consultations, a nadir blood glucose (BG) concentration and fructosamine or a BGC, along with biannual haematology, biochemistry and urinalysis (with culture). While guidelines may be beneficial in the approach to monitoring CDM, the way clinicians in primary care practice (PCP) routinely monitor CDM remains largely unknown. There are no specific studies assessing the monitoring practices of CDM in PCP and much of the recent available literature on CDM has originated from tertiary referral practice or research animals.[11–13] It is likely that these populations of dogs are different, along with the monitoring practices, due to a combination of disease demographic, financial limitations, owner and clinician preferences and the implementation of practice protocols.

Coupled with this, considerable variation exists in previous reports of CDM median survival times (MST): from 18 months to five years.[14–16] The aims of this pilot study were to describe how CDM is monitored in a single large PCP and to report the outcomes of affected dogs therein, and by extension, determine whether this suggests significant differences to the literature from referral settings and justifies further large-scale evaluation.

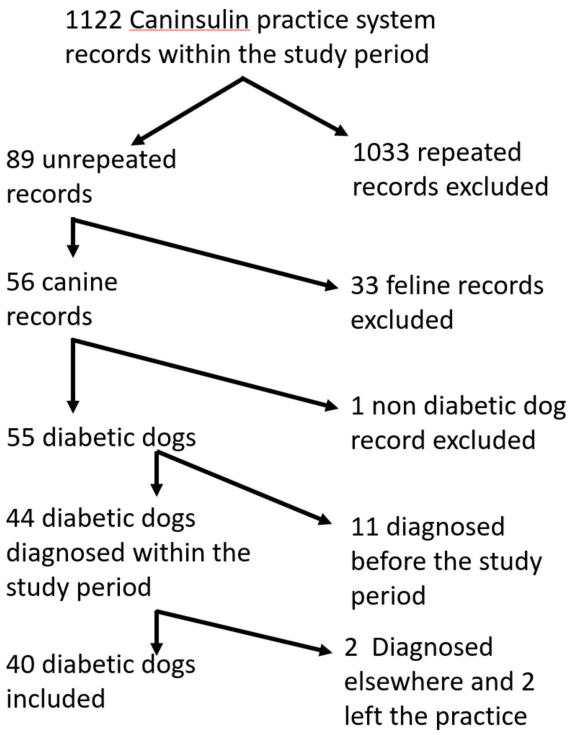

Figure 1 Review of Caninsulin logs from the primary care practice (PCP) records, highlighting exclusion criteria.

METHODS

Individual electronic patient records of diabetic dogs were collected retrospectively over five years (January 1, 2008 to December 30, 2012) from a large UK PCP (>20 primary care veterinarians with nine branches). For inclusion, dogs had to be diagnosed with CDM, including as a minimum, identification of persistent hyperglycaemia and glycosuria. Included dogs were treated with Caninsulin within the study period, remaining with the practice until study completion or until death/euthanasia. Animals diagnosed before January 1, 2008 or with incomplete records were excluded. For each dog, all appointments were evaluated and retrieved data were collected into an electronic spreadsheet (Microsoft Office Excel 2010). All diagnostic tests were recorded at each visit along with bodyweight (kg), clinical signs, test results and changes in insulin dose (iu/kg). Dogs were classified as stable if their clinical signs resolved, their weight was maintained/increased and their insulin dose was unchanged, with an acceptable fructosamine concentration (<500 µmol/l) or an acceptable BGC (online supplementary appendix 1). If a dog died or was euthanased, its age, duration of survival after diagnosis and cause of death were recorded. Any reasons for constraints over monitoring were recorded, such as aggression, finances or poor compliance.

Graphical figures were produced using a commercial statistical programme (GraphPad Prism V.5). Descriptive data are presented as the total number and percentage or median with the IQR in parenthesis. Continuous data were tested for normality with an Anderson-Darling test and assessed with a commercial software package (GraphPad Prism V.5) using a Student's *t* test or Mann-Whitney rank-sum test for non-parametric data. Statistical significance was set at P<0.05 and dogs were not censored for survival analysis if alive at study completion.

Table 1 The number of appointments (Apt) for all dogs included into the study, within the first month following diagnosis of CDM. The dogs are divided into alive or dead at one month after diagnosis

	Dogs (n)	
Apt in first month (n)	Alive after one month	Euthanased or dead after one month
>4	15	0
3	7	0
2	6	2
1	3	4
0	1	2

CDM, canine diabetes mellitus.

RESULTS

Forty dogs met the inclusion criteria (detailed in figure 1), which comprised five crossbreed dogs and 22 different purebreeds, the most frequent being West Highland white terriers,[5] Yorkshire terriers,[4] rottweilers[3] and dachshunds.[3] There were 20 neutered (50 per cent) and three entire (7.5 per cent) females, 10 neutered (25 per cent) and seven entire (17.5 per cent) males. Median age at diagnosis was nine years and six months (eight years six months to 10 years five months).

A total of 105 consults were recorded for the 40 dogs in the first month after diagnosis, with a median of three (two to four) consultations per dog (table 1). Eight dogs (20 per cent) were euthanased during the first month, two of these dogs had two monitoring appointments, four dogs had one monitoring appointment, one dog died and one was euthanased before their first monitoring appointment. There was a significant difference in the number of consultations between the 32 dogs alive after the first month and the eight deceased dogs (P<0.0005), three (two to four) months and 1.38 (one to two) months, respectively. In this first month after diagnosis, clinical signs were recorded at 79 (75.2 per cent) consultations, a single blood glucose (SBG) was performed at 76 (72.4 per cent), a BGC at 26 (24.8 per cent), weight at 49 (46.7 per cent) and fructosamine at 5 (4.8 per cent). No other tests were performed in this time period.

After the first month, until the end of the study period there were 367 consultations for 32 dogs, with a median of 7 (4–20) per dog. Each dog attended a consultation a median of every 19 (6–30) days. The longest period between consultations for any individual dog was 100 days. Clinical signs were recorded at 292 (77 per cent) consultations and weight was recorded significantly more frequently than the first month, at 248 (66.8 per cent) consultations (P<0.008). SBG and fructosamine

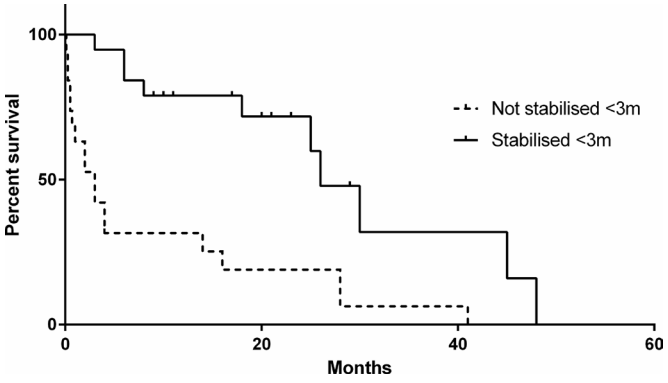

Figure 2 The total number of monitoring techniques used after the first month of the study period.

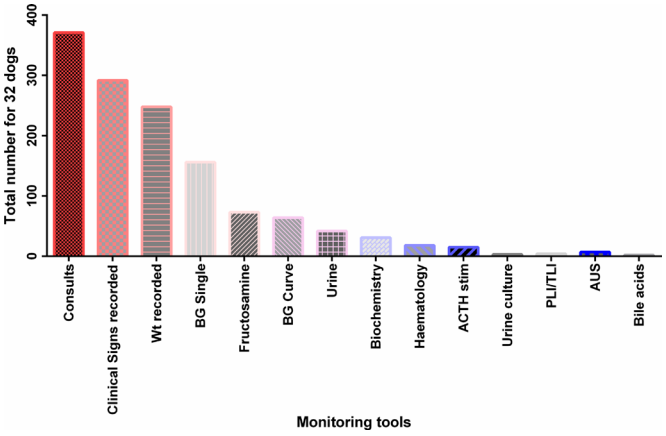

Figure 3 A Kaplan-Meier curve of survival, months after diagnosis, divided into dogs stabilised and those remaining unstable within less than three months. ACTH, adrenocorticotropic hormone; BG, blood glucose.

were measured at 156 (42 per cent) and 73 (19.8 per cent) consultations, respectively (figure 2). A BGC was performed following 64 (17.4 per cent) consultations and the median BGC duration throughout the study was 9.5 hours (8–24), having a median number of glucose concentrations recorded on each occasion of 6.[5–8] Serum biochemistry was performed at 31 (8 per cent), haematology at 18 (4.9 per cent) and urine culture at 3 (0.8 per cent) consultations. Home measurement of BG was recorded at one consultation. Over this period, other than records of weight and clinical signs, 14 of these 32 alive dogs (43.8 per cent) had SBG or fructosamine measured and no other monitoring tests were performed.

Twenty-three dogs (57.5 per cent) were considered clinically stable before the end of the study period, attaining the criteria indicated in the Methods section—resolution of clinical signs, stable to increasing weight and compatible diagnostic results; 10 dogs had an appropriate BGC, 4 had fructosamine concentrations suggesting excellent control, 5 good and 4 fair. Of the dogs not stabilising within the study period, one dog remained alive at study completion, the other 16 dogs were euthanased/died without confirmation of stability at any time point. The MST for all dogs (including 10 alive at study completion) was 8.5 months (2–21 months). There were 18 dogs that stabilised within three months of diagnosis, their MST was 20.5 months (10.25–25.75 months) (figure 3). This was significantly longer than the MST of 2.5 months (0–5.5 months) for the 22 dogs that were not stabilised within three months (P<0.001). A further three dogs stabilised after three months, their survival ranged from 10 months to three years five months (figure 3).

The median age at death, for the 30 dogs not alive at study completion, was 10 years six months, (nine years two months to 11 years 11 months). No postmortems were performed, however clinical records indicated that 21/30 dogs were euthanased or died due to complications arising from CDM, the remainder were either not recorded or unrelated to CDM, such as identification of additional conditions or neoplasia. Further tests or appointments were declined in four of the 21 dogs that deteriorated due to CDM and in four of the nine dogs with an unrelated illness or unknown cause.

DISCUSSION

This pilot study provides an interesting insight into how CDM is monitored in a large multicentre PCP. The results show that there is considerable variation in monitoring of CDM compared with the available guidelines, in particular, the type and frequency of the monitoring. A striking finding is the MST after diagnosis, which is shorter than previously reported in the literature. Taking into account that the survival of animals embarking on treatment for CDM will impact on the willingness to treat, this finding is very important. The median consultation frequency of three times in the first month, and thereafter, once approximately every month, is consistent with some suggested guidelines[4 9 10]; however, there was considerable variability, with some dogs not being seen for extended periods. It is difficult to retrospectively determine whether this is due to owners' perception of their dog's stability during the extended periods, or from veterinary advice. While perhaps the consultation frequency could be perceived as reasonable or comparable to guidelines, this study indicates infrequent diagnostic testing during the follow-up period for CDM in PCP and a variable selection of conducted tests. The finding that those dogs not surviving beyond the first month had significantly fewer consultations than those remaining alive (P<0.0005) warrants further investigation in a larger cohort as this may be an important observation influencing outcome. The infrequent use of BGC is striking, being performed at just 17.4 per cent of consultations after the first month, when considered to be an important method of assessment by the AAHA.[10] The retrospective nature of this pilot study makes the factors influencing the choice to perform a BGC unknown but considerations would be: individual clinician preferences, along with patient factors such as cost, compliance, available resources and time. BGCs have their own limitations, such as variability, high cost, and they are impacted by stress, which may be a reason for low utility.[17] Importantly, however, it appeared from the clinical records that BGCs were predominantly

performed when cases were considered unstable, though the degree of instability was however difficult to discern in each case. An important aspect to highlight was the short period over which the BGCs were performed in the clinic. Fundamental to performing a BGC is its value in providing information to guide changes in managing CDM. In many cases the period of assessment of the BGC was perhaps too short to be of maximal clinical value (eg, five hours) especially as key aspects, such as evaluating the glucose nadir and duration of action, would have been missed. This is therefore an important aspect for further study, particularly to discern whether BGCs completed in PCP offer value for money to the clients and facilitate optimal decision-making.

The frequent use of an SBG is surprising given the limited information it reportedly provides especially if not taken at the nadir.[17] Due to the retrospective nature of the study, the timing of the SBG was unclear for the majority of occasions and therefore its clinical utility in this respective case series remains unknown. Even when the nadir is known, the practical benefit is questionable due to the variability of glycaemic curves.[17] Despite this, the use of SBG at the nadir is part of the recommendations of the AAHA[10] and this may be due to a combination of cost and practicality. Understanding more about the rationale behind this frequent use of SBG is therefore important as slight modifications in the timing of the SBG may improve their perceived utility (according to the AAHA).

Home monitoring of BG is supported by the current AAHA recommendations and its lack of utility here is surprising, as it can be a practical technique and provide an accurate representation of glycaemic control.[18] Urine glucose measurements were also not reported for any dogs. Future prospective evaluations of CDM monitoring should include the utility of these techniques.

The reason for increased weight measurements after the first month is unclear, though this is undoubtedly important as it provides invaluable insight into glycaemic control[19] and importantly confers no extra cost to the client. It was of interest that fructosamine was not measured within the first month but was measured thereafter. While the reason for this was not appreciated from the clinical records, this could be due to perceived importance of using fructosamine to review longer term stability.

In this pilot study, urine cultures were conducted infrequently and in each case were completed during periods of clinical instability, suggesting this may have been the reason for the test to have been conducted. Given their occult nature, urinary tract infections (UTI) may have been missed and because UTIs are well recognised as impacting on stability of CDM,[4 20] their infrequent use in this cohort is surprising and may have effected outcomes. A valuable question to answer in a larger scale prospective study would be: What influences the decision to perform urine cultures in CDM? Haematology and serum biochemistry were also measured infrequently in this population (figure 1), which is interesting, as these would be considered 'routine' test in PCP, especially considering the importance of comorbidities in influencing diabetic stability and outcome.[21] When examining this in terms of the AAHA guidelines, regular screening using these particular parameters is advocated. It was difficult to establish why these tests were used so infrequently. Occasionally, free-text information was available within the clinical notes but this was insufficient in the majority of cases to reveal the rationale. This highlights a limitation, as with other retrospective studies; understanding the rationales behind decision-making. Ultimately, the outcome of any clinical research is to better inform future clinical decisions, and due to a current lack of understanding decision-making practices in CDM, it makes improvements difficult. This point alone clearly demonstrates the value of a PCP-based prospective follow-up study, which collects these important details on a large enough scale to have a robust relationship with PCP in general.

The MST after diagnosis is shorter than previously described,[4 14–16] however, as survival analysis in previous studies varies, a direct comparison becomes difficult. For example, Foster[16] and Doxey *et al* (1986) excluded 30 and 33 per cent of cases that died within one month of diagnosis, giving mean survivals of 1.75 years and 18 months, respectively. Excluding dogs that did not survive the first month from our cohort increases the MST to 16 months. By contrast, the 55 per cent stabilisation rate in our cohort compares favourably with previous reports.[14 16] One particular interesting and potentially valuable result, which requires further evaluation, is that achieving stability, especially within three months, was associated with improved survival; this has not been previously reported. An additional aspect, which cannot be appreciated from this retrospective study, is owner perception of quality of life in affected dogs. The literature would suggest that owner satisfaction of diabetic dogs is variable and as low as 50 per cent are satisfied.[22] It would therefore be a key aspect of a prospective study to determine the degree of satisfaction and perhaps more importantly whether this is linked to stability and survival times and a number of quality of life tools are available for this purpose.[23]

In conclusion, the findings from this pilot study show interesting variance of monitoring practices and survival from much of the literature regarding CDM and from the AAHA guidelines in 2010,[10] which have recently updated these in 2018.[24] The reasons for this substantial variation from the currently accepted CDM data and guidelines justify a larger study and prospective evaluation of monitoring practices are necessary. The findings from this particular PCP may be generally applicable to the majority of PCPs but recruitment of a larger number of PCPs is the essential next step in determining this. As part of a prospective study, evaluating the use and perceived effectiveness and practicalities of the AAHA (or other such) guidelines would also be valuable. If we tenuously

extrapolate from this pilot study cohort, survival of CDM in PCP has not improved in the UK since 1985, this alone suggests prospective studies in PCP using the guidelines are essential to establish whether their use improves stability and survival of CDM and if not, what does?

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